Check List the journal of biodiversity data

NOTES ON GEOGRAPHIC DISTRIBUTION

Check List 16 (1): 253–264
https://doi.org/10.15560/16.1.253

PENSOFT

New records of Myxomycetes from Peru

Italo F. Treviño-Zevallos[1, 2], Carlos Lado Rodriguez[1]

1 Real Jardín Botánico (CSIC), Plaza de Murillo 2, 28014 Madrid, Spain. **2** Universidad Nacional de San Agustín de Arequipa, Daniel Alcides Carrión s/n, Arequipa, Peru.
Corresponding author: Italo F. Treviño-Zevallos, ifrant01@gmail.com

Abstract

We report 19 species of Myxomycetes for first time in Peru. *Macbrideola spinispora* L.M. Walker, G. Moreno & S.L. Stephenson, previously known only from the type collection from Costa Rica, is now reported for South America, enlarging its distribution considerably. The Myxomycetes were collected in Wayqecha Biological Station, a conservation area in the Cuzco region. The specimens were deposited in the South Peruvian Herbarium (HSP) and the Real Jardín Botánico de Madrid (MA-Fungi). The number of Myxomycetes currently recorded from Peru is increased to 174 species.

Keywords
Amoebozoa, distribution, diversity, montane forest, Myxobiota, Neotropics.

Academic editor: Adalgisa Fernanda Cabral | Received 31 October 2019 | Accepted 3 February 2020 | Published 13 March 2020

Citation: Treviño-Zevallos IF, Lado C (2020) New records of Myxomycetes from Peru. Check List 16 (2): 253–264. https://doi.org/10.15560/16.2.253

Introduction

The Myxomycetes are amoeboid protists included in Amoebozoa. These microorganisms have been considered for many years as a special group of fungi (Kirk et al. 2011) since they reproduce by spores generated in static fruiting bodies. However, the trophic phases are amoeboid and Myxomycetes are now considered to be protists. Most of these organisms-barely exceed a millimeter in size and are found in all terrestrial ecosystems. They have been traditionally associated with humid temperate environments, due to the need for water to complete their life cycle, but their presence in arid environments is also frequent (Lado et al. 2016, 2019).

The current catalogue of Myxomycetes of Peru has 155 taxa recorded, and these come from the studies carried out over the last decade in the Tropical Rainforest of Madre de Dios (Rojas et al. 2011; Rojas and Stephenson 2013) and the arid areas of Lomas and cardonal habitats, where some new species have been described (Wrigley de Basanta et al. 2015, 2019; Lado et al. 2016, 2019). This list is far from complete, however.

Montane forests are considered as one of the most diverse zones for plants of the Amazon region (Young and León 2001). This diversity is even greater when associated microorganisms, such as the Myxomycetes, are also included, but unfortunately these are scarcely studied, and only three records have been published (Rojas et al. 2011). With this paper, we contribute to the knowledge of the diversity of Peruvian Myxomycetes in this kind of forest.

Methods

All the material studied is from Wayqecha Biological Station (Fig. 1A), a private conservation area managed by the Association for the Conservation of the Amazon Basin, ACCA (Rivera 2007; Medina et al. 2012). It

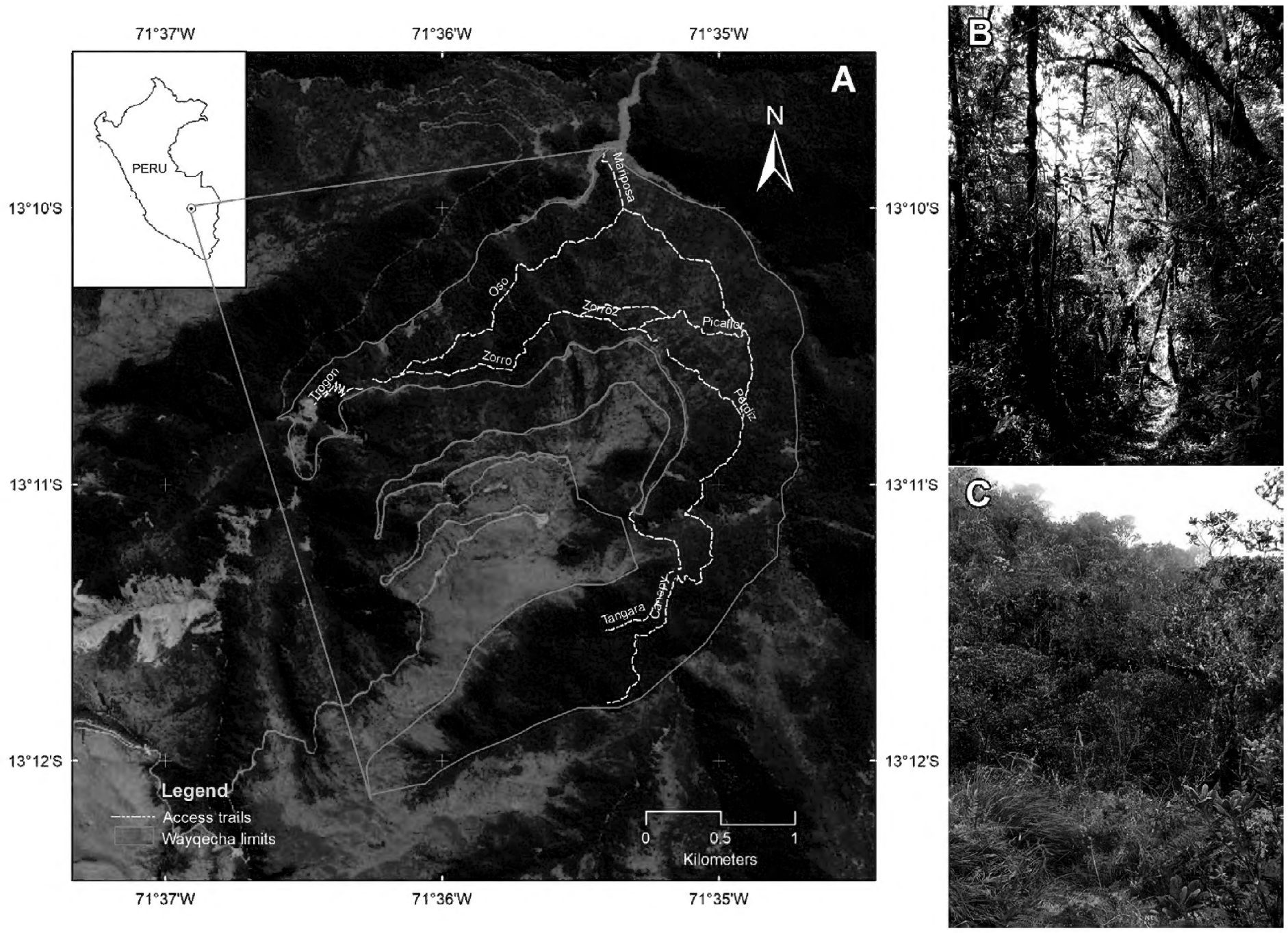

Figure 1. A. Map of Wayqecha Biological Station (WBS). **B, C.** View of montane forest in WBS.

is located in the Cusco Region, Paucartambo Province, near Km 117 on the Cusco–Pilcopata route (13°10′31″S, 71°35′12″W). The study area is at elevations between 2300 and 3500 m a.s.l. All collections were made during two expeditions, which were conducted by one of us (IFTZ). Each expedition, at the end of January and in May of 2018, lasted for one week. The flora of the area is very diverse and montane forest is dominant (Fig. 1B, C). Two forest zones were distinguished within the Wayqecha Biological Station. The first zone is in the lower part of the station nearestthe river. There, dense stands of *Weinmannia* and *Myrsine* trees are dominant, but also with a remarkable presence of epiphytic bromeliads and orchids. The second zone has more dispersed trees and shrubs, which gives an aspect of a sparser and less humid forest. The dominant trees and shrubs in this second zone belong to the genera *Clethra* and *Oreocallis*, as well as representatives of the family Ericaceae. Finally, the highest part of the Wayqecha Biological Station are transitional to the Andean grasslands.

We deposited our specimens of Myxomycetes in the Peruvian South Herbarium (HSP) managed by the Instituto Científico Michael Owen Dillon (Arequipa, Peru), with duplicates of some species in the Herbarium of the Real Jardín Botánico de Madrid (MA-Fungi). The specimens were identified using monographs of the group such as Martin and Alexopoulos (1969), Farr (1976), Nannenga-Bremekamp (1991), Lado and Pando (1997), Poulain et al. (2011), and other specialized literature. The nomenclature follows Lado (2005–2019), and the species descriptions are based on direct examination of the Peruvian collections. For colour designation, we have used the ISCC-NBS colour-name charts illustrated with centroid colours (Kelly 1965). We include the alpha numeric code used by Kelly (1965). The colours provided for the structures are based on observations made in reflected daylight, except, where indicated, those made under microscope using transmitted light (TL) with a halogen lighting system. Measurements of the sporocarps are represented by two values, the first representing height and the second width. For plasmodiocarpic fructification three measurements are given, the first one indicates the length of the longest axis, the two following are the height and width respectively, measured on a plane at right angle to the longest axis and the substratum surface (Lado and Pando 1997). Measurements of spores and capillitia include any surface structures or ornamentation, and measurements of stalks and columellae were taken at the longitudinal middle. Distributional data for the species in the Neotropics are based on Lado and Wrigley de Basanta (2008), but for Peru these data has been updated with the information in recent publications (Lado et al. 2008, 2016, 2019; Rojas et al. 2011; Wrigley de Basanta et al. 2008, 2015, 2019).

Results

Our study contributes new records of 19 species of Peruvian Myxobiota. This represents a 12% increase of in the number of Myxomycetes species recorded in the country, which now is 174.

Arcyria pomiformis (Leers) Rostaf.

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, Zorro trail to Esperanza (13.173°S, 071.594°W, 2821 m alt.), *I. Treviño & J. Muñuico,* 1 Feb. 2018, leaf litter, *Myx-317* (HSP).

Identification. Sporocarps solitary or grouped, stalked, 1.4–2 mm in total height. Hypothallus membranous, individual, discoid, shiny. Stalk cylindrical, erect, 0.5–0.8 mm long, 0.06–0.09 mm wide, longitudinally grooved, dark grayish brown (62. d. gy. Br), filled with cysts of 17.5–20 µm in diameter. Sporotheca subglobose, 0.9–1.2 mm in diameter after expansion of the capillitium, grayish yellow (90. gy. Y). Peridium membranous, evanescent, remaining in the basal part as a calyculus of 0.5 mm in diameter, yellowish brown (77. m. y Br). Capillitium netted, tubules attached to the calyculus, flexuous, elastic, branched and anastomosed, 3–5 µm in diameter, ornamented with spines, half-rings, rings, or teeth. Spores free, grayish yellow (90. gy. Y) in mass, colourless by TL, globose, 7–8 µm in diameter, faintly warted, with scattered groups of more prominent warts.

Notes. This species is distributed worldwide, but not previously recorded from Peru. In the Neotropics, this species was previously reported from Mexico, Panama, Cuba, Venezuela, Brazil, Paraguay, and Argentina. *Arcyria pomiformis* resembles *A. cinerea* (Bull.) Pers. but differs in the subglobose sporotheca, with a wide-meshed capillitial reticulum, and the tubules of the capillitium yellowish or ochraceous and more densely ornamented. The specimens agree with the description provided by Lado and Pando (1997), except for the size of the cysts, which are a little smaller in our Peruvian specimen (17.5–20 µm vs 24–30 µm in diameter).

Comatricha alta Preuss

Figure 2A

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, Canopy trail (13.193°S, 071.589°W, 2944 m alt.), *I. Treviño & J. Muñuico,* 2 Feb. 2018, bark of decayed branches, *Myx-282b* (HSP).

Identification. Sporocarps grouped, stalked, 5–7.5 mm in total height. Hypothallus membranous, individual, or common to a group of sporocarps, discoid or effuse, opaque. Stalk cylindrical, erect, sometimes curved, 4.5–6.5 mm long, 0.03–0.05 mm wide, blackish (65. br Black). Sporotheca short cylindrical, 0.5–1 × 0.25–0.3 mm, yellowish brown (81. gy. y Br). Columella cylindrical, reaching the apex of the sporotheca, 0.5–1 mm long, 0.01 mm wide, blackish (65. br Black). Capillitium netted, threads 2–2.5 µm in diameter, branched and anastomosed, flexuous, elastic, grayish brown (61.gy. Br) by TL. Spores free, grayish brown (81. gy. y Br) in mass, yellowish brown (75. deep y Br) by TL, globose, 7.5–10 µm in diameter, with small and inconspicuous warts.

Notes. This species is known from Europe (Ing 1999), Asia (Martin and Alexopoulus 1969), New Zealand (Stephenson 2003), South Africa (Ndiritu et al. 2009), Japan, Australia, and USA (GBIF 2020). This is the second record of this species for the Neotropics. It was previously reported by Lado et al. (2013) from Chile. *Comatricha alta* is characterized by the capillitium that at the upper part falls away from the columella, like a long plume (Nannenga-Bremekamp 1991). *Comatricha fragilis* Meyl. also has a capillitium which falls off the columella but it does not expand, and the fruiting bodies are smaller, about 2 mm in total height versus 5–7.5 mm in *C. alta*.

Craterium minutum (Leers) Fr.

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, Canopy trail (13.193°S, 071.589°W, 2944 m alt.), *I. Treviño & J. Muñuico*, 31 Jan. 2018, leaf litter, *Myx-282b* (HSP). Wayqecha Biological Station. (13.172°S, 071.596°W, 2662 m alt.), *I. Treviño & S. Huamaní,* 1 June 2018, leaf litter, *Myx-513a* (HSP).

Identification. Sporocarps grouped, stalked, 0.9–1.2 mm in total height. Hypothallus membranous, individual, discoid, shiny. Stalk cylindrical, erect, longitudinally grooved, 0.4–0.6 mm long, 0.04–0.06 mm wide, yellowish brown (75. deep y Br). Sporotheca conical, with convex apex, 0.5–0.7 mm in diameter, yellowish (87. m. Y). Peridium double, with two appressed layers: outer layer subcartilaginous and usually limeless, inner layer membranous and limy, dehiscence by a regular, complete lid. Columella and pseudocolumella absent. Capillitium netted, with large white (263. White) lime nodes, connected with thin, colourless tubules. Spores free, reddish brown (46. gy. r Br) in mass, grayish brown (45. l. gy. r Br) by TL, globose, 8–10 µm in diameter, warted.

Notes. This is species is distributed worldwide but has not so far been reported from Peru. In the Neotropics, it has been reported from Mexico, Cuba, Colombia, and Brazil. The species is characterized by the grouped, yellowish brown sporocarps and by the conical sporotheca with a typical dehiscence by a regular, complete lid. Macroscopically it looks like *C. concinnum* Rex but differs in the number of layers of the peridium (single en *C. concinnum* vs double in *C. minutum*). The morphology of the specimens collected in EBW corresponds to the description sprovided by Farr (1976) for tropical collections, and Nannenga-Bremekamp (1991) for specimens from temperate regions, except for the presence of a pseudocolumella, which is absent in our material.

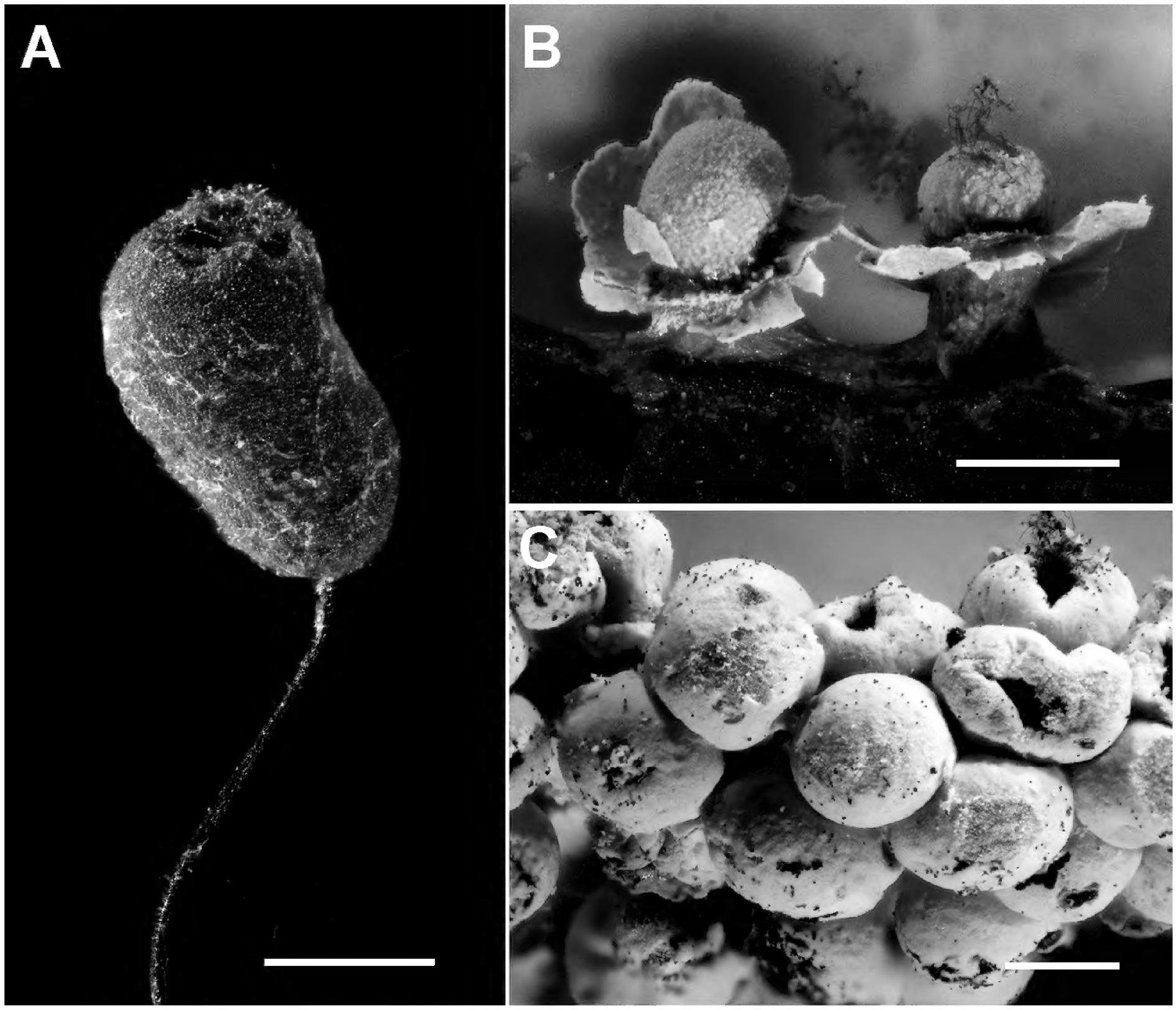

Figure 2. A. *Comatricha alta, IT-Myx-282b* (HSP), stalked sporocarp. **B.** *Diderma fragile IT-Myx-410* (HSP, MA-Fungi 91788), two open sporocarps showing the columella and a remainder of the capillitium. **C.** *Diderma subdyctiospermum IT-Myx-393* (HSP), several sporocarps. Scale bars: A = 0.25 mm; B, C = 0.5 mm.

Craterium obovatum Peck

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station (13.193°S, 071.589°W, 2943 m alt.), *I. Treviño & S. Huamaní,* 2 June 2018, leaf of *Greigia* sp., *Myx-564* (HSP, MA-Fungi 91809); Wayqecha Biological Station (13.1930°S, 071.589°W, 2943 m alt.), *I. Treviño S. Huamaní,* 2 June 2018, in grass, *Myx-581* (HSP).

Identification. Sporocarps grouped, stalked, 1.2–2 mm in total high. Hypothallus membranous, individual, discoid, opaque. Stalk cylindrical, erect, 0.8 mm long, 0.09–0.11 mm wide, reddish black (24. r Black), filled with crystalline lime concretions. Sporotheca subglobose to slightly obovoid, 0.4–0.7 mm in diameter, reddish black (24. r Black) at the base turning grayish brown (61. gy. Br) at the apex. Peridium membranous, slightly limy, fragile, single, pale yellow (89. p. Y), dehiscence irregular. Columella cylindrical, 0.25–0.4 mm long, 0.04–0.06 mm wide, reddish black (24. r Black). Capillitium arising from the columella, netted, with irregular white (263. White) lime nodes, connected by thin, colourless tubules. Spores free, blackish (65. br. Black) in mass, grayish brown (46. gy. r Br) by TL, paler in one side, globose, 12.5–15 µm in diameter, warted and with an interrupted reticulum.

Notes. This species is widely distributed in Europe, America, and Asia (Martin and Alexopoulos 1969; Polain et al. 2011). In the Neotropics, it was previously reported from Mexico, Uruguay, and Argentina. This species is characterized by the unique ornamentation of the spores, which are warted and with an interrupted reticulum (Poulain et al. 2011). It also differs from other species of *Craterium* by its true calcareous cylindrical columella.

Cribraria mirabilis R.K. Benj. & Poitras

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station (Zorro trail to Esperanza), (13.173°S, 071.594°W, 2821 m alt.), *I. Treviño & J. Muñuico,* 1 Feb. 2018, bark of decayed branches, *Myx-322* (HSP).

Identification. Sporocarps grouped, stalked, around 3 mm in total height. Hypothallus membranous, individual, effuse, shiny. Stalk cylindrical, erect, sometimes slightly curved, longitudinally grooved, 2.2–2.5 mm long, 0.05–0.07 mm wide, blackish (65. br. Black). Sporotheca globose, 0.4–0.5 mm in diameter. Peridium membranous, grayish brown (47. d. gy. r Br), evanescent, remaining as 20 to 25 ribs, which reach from the base to over half way up the sporotheca. These ribs merge into an irregular net; lime globules ca. 1 µm in diameter concentrated on the ribs and nodes of the net. Spores free, yellowish brown (61. l. y Br) in mass, yellowish white (92. y White) by TL, globose, 5–7 µm in diameter, minutely warted.

Notes. This worldwide species was not previously recorded from Peru. In the Neotropics, it was previously reported from Mexico, Costa Rica, Brazil, and Chile. According to Farr (1976), this species is native to mountains or cold climates, but this statement seems unproven. The species is distinguished from *C. cancellata* (Batsch) Nann.-Bremek. by its erect or suberect fruiting bodies and by the number of peridial ribs, 20–25 in our specimen vs 40–50 in *C. cancellata*.

Cribraria vulgaris Schrad.

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.176°S, 071.582°W, 2705 m alt.), 29 May 2018, on bark of *Hesperomeles* sp., *I. Treviño & S. Huamaní, Myx 376* (HSP). Wayqecha Biological Station (Oso trail), (13.178°S, 071.582°W, 2717 m alt.), 28 Jan. 2018, on bryophyte, *I. Treviño & J. Muñuico, Myx-149* (HSP).

Identification. Sporocarps grouped, stalked, 2.1–2.5 mm in total height. Hypothallus membranous, individual, effuse, opaque. Stalk cylindrical, erect, longitudinally grooved, 1.7–2 mm long, 0.05–0.09 mm wide, brownish black (65. br Black). Sporotheca globose, 0.4–0.7 mm in diameter. Peridium membranous, grayish brown (62. d. gy. Br), partially evanescent, remaining in the lower ¼ to ½ of the sporotheca as a calyculus, in the rest as an irregular net with flat, widened irregular nodes; lime globules ca 1 µm in diameter concentrated in the nodes of the net and in the calyculus as radiating lines. Spores free, orange yellow (67. brill. O Y) in mass, yellowish white (92. y White) by TL, globose, 6–7.5 µm in diameter, minutely warted.

Notes. This species has a large distribution in the northern hemisphere and can also be rarely found in New Zealand and Australia (Mitchell 1995; Stephenson 2003). In the Neotropics, it was previously reported from Mexico, Costa Rica, Brazil, and Argentina. This species is characterized by a net with flat, widened irregular nodes. Another closely similar species is *C. oregana* H.C. Gilbert, but these two species differ in the diameter of their spores (6–7.5 µm in *C. vulgaris* vs 8–9.5 µm in *C. oregana*) and the ornamentation of their calyculus (marked with longitudinal fold with granules in *C. vulgaris* vsabsent in *C. oregana*).

Diderma fragile **Aramb.**
Figure 2B

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.177°S, 071.584°W, 2851 m alt.), 30 May 2018, on bryophyte and leaf litter, *I. Treviño & S. Huamaní, Myx-410* (HSP, MA-Fungi 91788).

Identification. Sporocarps grouped, stalked, 1–1.3 mm in total height. Hypothallus membranous, common to a group of sporocarps, effuse, shiny. Stalk short, cylindrical, erect, longitudinally grooved, 0.3–0.45 mm long, 0.3–0.35 mm wide, yellow (87. m. Y). Sporotheca subglobose, 0.7–1 mm in diameter, yellowish white (92. y White). Peridium double, with two appressed layers, the outer layer calcareous, fragile, eggshell-like, yellowish white (92. y White), concolorous in the inner side but turning yellowish brown (78. d. y. Br) at the base of sporotheca, the inner layer membranous, colourless, dehiscence irregular. Columella subglobose, 0.4–0.5 mm in diameter, that occupies almost 2/3 of the sporotheca, rough, orange-yellow (70. l. O Y). Capillitium radiating from the columella, thread-like, yellowish brown (75. deep y Br) by TL, with pale areas, threads 1–2.5 µm in diameter, scarcely branched, with irregular surface due to protuberances. Spores free, blackish (65. br Black) in mass, reddish brown (42. l. r Br) by TL, pale in one side, globose, 12.5–15 µm in diameter, spinulose.

Notes. This species, previously only known from Argentine Tierra del Fuego, is reported for the first time outside Argentina. The distinctive characters of *D. fragile* are the short stalks, the spiny spores, and the well-developed calcareous columella, which occupies ⅔ of the size of the sporotheca (Arambarri 1973). The Peruvian specimen corresponds to the original description, but the spines of the spores seem less marked.

Diderma subdictyospermum **(Rostaf.) E. Sheld.**
Figure 2C

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.169°S, 071.591°W, 2543 m alt.), 30 May 2018, on leaf of *Rhynchospora* sp. and bryophyte, *I. Treviño & S. Huamaní, Myx-415* (HSP, MA-Fungi 91789). Wayqecha Biological Station, (13.177°S, 071.581°W, 2711 m alt.), 29 May 2018, on frond of fern, *I. Treviño & S. Huamaní, Myx-393* (HSP, MA-Fungi 91782).

Identification. Sporocarps aggregated, sessile. Hypothallus calcareous, common to a group of sporocarps, effuse, opaque. Sporotheca subglobose, 0.4–0.8 mm in diameter, yellowish white (92. y White). Peridium double, the layers well differentiated, the outer layer calcareous, eggshell-like, yellowish white (92. y White), the inner layer membranous, light gray (264. l. Gray), dehiscence irregular. Columella, globose, 0.2 mm in diameter, yellowish white (92. y White). Capillitium arising from

the columella, thread-like, 2–2.5 µm in diameter, sparingly branched, anastomosing near the peridium, brown (58. m. Br) by TL. Spores free, dark brown (62. d. gy. Br) in mass, light brown (57. l. Br) by TL, 12.5–14 µm in diameter, subreticulate.

Notes. A rare species, only recorded from India, Sri Lanka, Java, Taiwan, Japan, Kenya, and South Africa (Yamamoto et al. 2006; Ndiritu et al. 2009; Poulain et al 2011). In the Neotropics, this species was previously only reported from Mexico and Venezuela. This species looks like *Diderma spumarioides* (Fr. & Palmquist) Fr., but it differs in the ornamentation of the spores, which are warted in *D. spumarioides* and subreticulate in *D. subdictyospermum*.

***Didymium minus* (Lister) Morgan**

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station (Canopy trail), (13.193°S, 071.589°W 2944 m alt.), 31 Jan. 2018, leaf litter, *I. Treviño & J. Muñuico, Myx-278b* (HSP).

Identification. Sporocarps scattered or grouped, stalked, 0.6–1.1 mm in total height. Hypothallus membranous, individual, discoid, opaque. Stalk, cylindrical, erect, longitudinally grooved, 0.4–0.6 mm long, 0.1–0.12 mm wide, black (267. Black). Sporotheca subglobose to hemispherical, 0.5–0.6 × × 0.3–0.5 mm, white (263. White). Peridium single, membranous, thin, fragile, brown but with pale bands, areolate, covered with stellate lime crystals, dehiscence irregular. Columella, subglobose, grayish brow (62. d. gy. Br), occupying about ⅓ of the sporotheca. Capillitium arising from the columella, thread-like, 1–2 µm in diameter, scarcely branched, grayish brown (45. l. gy r Br) by TL. Spores free, brown (64. br. Gray) in mass, light grayish brown (45. l. gy r Br) by TL, globose, 10–12.5 µm in diameter, warted and with groups of darker warts.

Notes. This species is distributed worldwide, but it has not previously been reported from Peru. It closely resembles *Didymium nigripes* (Link) Fr. but differs in the more narrowly umbilicate sporotheca, with longer stipes which are greater than 1 mm long, and the presence of darker thickenings in the threads of the capillitium (Farr 1976).

***Macbrideola spinosispora* L.M. Walker, G. Moreno & S.L. Stephenson**

Figures 3A–C

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.176°S, 071.582°W, 2705 m alt.), 28 Jan. 2018, moist chamber culture pH = 5.97, 14 Dec. 2019, leaf litter, *I. Treviño Myx-627* (HSP, MA-Fungi 90495).

Identification. Sporocarps scattered, stalked, 350–450 µm in total height. Hypothallus membranous, individual, discoid, shiny. Stalk, cylindrical, erect, 200–250 µm long, 10–15 µm wide, hollow, dark reddish brown (44. d r Br), turning strong yellowish brown (74. s y Br) at the base. Sporotheca globose, 140–230 µm in diameter, grayish brown (61. gy. Br). Peridium evanescent but leaving a small collar at the base of the sporotheca. Columella cylindrical, 120–200 µm long, 6–7 µm in diameter, narrowed toward the apex. Capillitium arising from the columella, scanty, filiform, 1–2 µm in diameter, branched, slightly flexuous, with acute ends, pinkish gray (10. pk Gray) by TL. Spores free, grayish brown (61. gy Br) in mass, brownish pink (33. br Pink) by TL, globose, 8–9 µm in diameter, with few evenly distributed but well-marked spines.

Notes. No species of *Macbrideola* has been reported previously from Peru. *M. spinosispora*, which was only known from the type material from Costa Rica, is recorded for the first time from South America. Therefore, this new record considerably expands this species' distribution . This species is characterized by its small size, the colour of the sporotheca, the hollow stalk with a yellowish brown base that contrasts with the rest, which is very dark brown, the scanty capillitium, and especially the spiny spores (Walker et al. 2014). The Peruvian specimens correspond well with the original description, except in the colour of the sporotheca, which is grayish-brown in our specimen but violaceous in the original description. The Peruvian specimen was obtained from leaf litter cultured in a moist chamber, which is the same substrate as the original type material. We suggest that this species may be foliicolous and adapted to tropical areas.

***Metatrichia floriformis* (Schwein.) Nann.-Bremek.**

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.177°S, 071.602°W, 2765 m alt.), 31 May 2018, on bark of dead tree, *I. Treviño & S. Huamaní, Myx-462* (HSP, MA-Fungi 91795). Wayqecha Biological Station, (13.176°S, 071.584°W, 2868 m alt.), 02 June 2018, on bark of dead tree, *I. Treviño & S. Huamaní, Myx-561* (HSP, MA-Fungi 91808).

Identification. Sporocarps grouped, stalked, 2.5–3.2 mm in total height. Hypothallus membranous, common to a group of sporocarps, effuse, opaque. Stalk cylindrical sometimes compressed laterally, longitudinally grooved, 1.6–2.1 mm long, 0.08–0.2 mm wide, dark brown (59. d. Br) toward the apex, yellowish brown (74. s. y Br) to orange-yellow (71. m. O Y) at the base. Sporotheca subglobose to obovate, 0.7–1.3 mm in diameter, black (267. Black) to dark grayish brown (47. d. gy. r Br). Peridium double, the two layer appressed, the outer layer thick, coriaceous, persistent, the inner layer thin, membranous, dehiscence irregular at the upper part or slightly petaloid. Capillitium tubular, elateriform, 5–6 µm in diameter, flexuous, elastic, occasionally branched, with acute free ends of 25–37.5 µm long, yellow (83. brill. Y) by TL, ornamented with 4 or 5 spiral bands. Spores free,

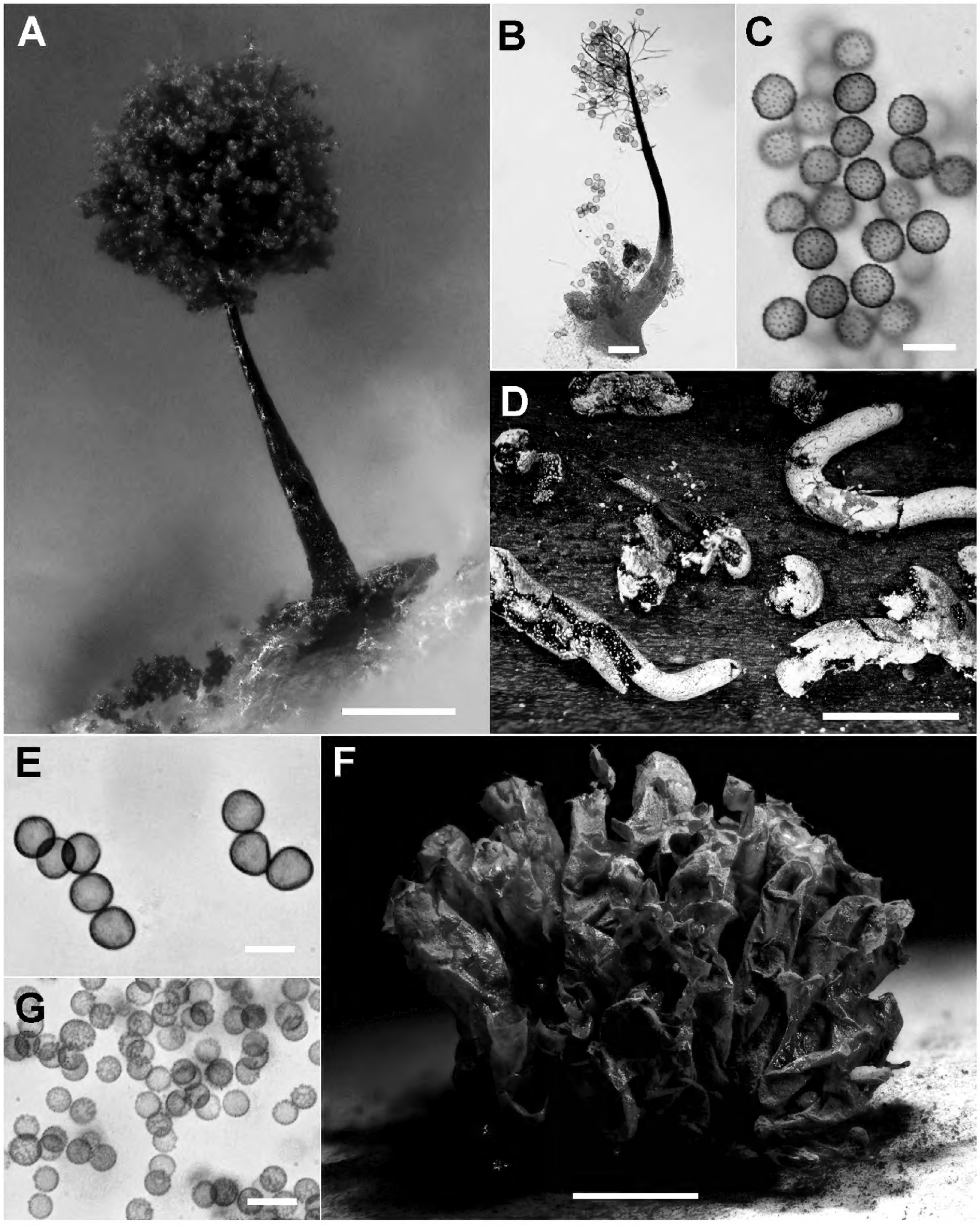

Figure 3. A–C. *Macbrideola spinosispora, IT-Myx-627* (HSP, MA-Fungi 90495): (**A**) stalked sporocarp; (**B**) sporocarp by transmitted light (TL), showing the pale base of the stalk and the scanty capillitium; (**C**) spiny spores by TL. **D, E.** *Physarum sessile, IT-Myx-514* (HSP, MA-Fungi 91804): (**D**) plasmodiocarps and sporocarps; (**E**) spores by TL. **F, G.** *Tubifera ferruginosa, IT-Myx-353* (HSP, MA-Fungi 91775): (**F**) sporocarps aggregated in a pseudoaethalioid fructification; (**G**) spores by TL. Scale bars: A = 0.1 mm; B = 20 µm; C, E, G = 10 µm; D = 1 mm; F = 2 mm

brilliant yellow (83. brill. Y) in mass, light yellow (86. l. Y) by TL, 10–12.5 µm in diameter, warted.

Notes. This species, which is distributed worldwide, has not previously been reported from Peru. *Metatrichia floriformis* resembles *M. vesparia* (Batsch) Nann.-Bremek. ex G.W. Martin & Alexop., but it differs in that the sporocarps that are not crowded, the darker is peridium, and the elaters are devoid of spines and with longer acute free ends (25–37.5 µm long in *M. floriformis* vs. 15–20 µm long in *M. vesparia*).

***Physarum brunneolum* (W. Phillips) Massee**

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.178°S, 071.581°W, 2719 m alt.), 29 May 2018, on bryophyte, *I. Treviño & S. Huamaní, Myx-400* (HSP).

Identification. Sporocarps grouped, stalked, 0.8–1.2 mm in total height. Hypothallus inconspicuous. Stalk cylindrical, erect, longitudinally grooved, 0.2–0.5 mm long, 0.1–0.15 mm wide, orange yellow (67. brill. O Y). Sporotheca subglobose, 0.5–0.9 mm in diameter, orange-yellow (67. brill. O Y) turning yellowish brown (74. s. y Br) at the apex. Peridium triple, thick, with the layers closely appressed, the outer layer coriaceous, orange yellow (67. brill. O Y), the middle layer calcareous, white (263. White), the inner layer membranous, colourless, dehiscence irregular. Capillitium netted, with irregular lime nodes, pale yellow (89. p. Y), connected by colourless tubules of 1.5 µm wide. Spores free, brownish black (65. br Black) in mass, light brown (57. l. Br) by TL, globose, 12–12.5 µm in diameter, warted.

Notes. This species is known from Europe, USA, Australia, and Japan (Mitchell 1995; Poulain et al. 2011). In the Neotropics, it has been previously reported from Mexico, Costa Rica, Colombia, and Chile. This species is characterized by the orange to brownish sporotheca, by the thick, triple peridium, with a white, calcareous middle layer, and by the strongly calcareous capillitium (Farr 1976).

***Physarum penetrale* Rex**

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.169°S, 071.591°W, 2543 m alt.), 30 May 2018, leaf litter, *I. Treviño & S. Huamaní, Myx-419* (HSP).

Identification. Sporocarps grouped, stalked, 1–1.8 mm in total height. Hypothallus membranous, individual, shiny. Stalk cylindrical, erect, 0.5–1.4 mm long, slender, 0.03–0.05 mm wide, yellow (83. brill. Y). Sporotheca subglobose to ellipsoid, 0.6–0.7 × 0.45–0.6 mm, grayish (264. l. Gray). Peridium single, membranous, covered by white calcareous granules, fragile, dehiscence irregular. Columella cylindrical, almost reaching the apex of the sporotheca, 0.4–0.5 mm long, 0.03–0.04 mm in diameter, yellow (83. brill. Y). Capillitium netted, arising from the columella, with irregular small lime nodes, white (263. White), connected by colourless tubules of 1.5–2.5 µm in diameter. Spores free, dark brown (62. d. gy. Br) in mass, light brown (79. l. gy. Br) by TL, globose, 6–7.5 µm in diameter, warted with groups of darker warts.

Notes. This species has a worldwide distribution but was not previously reported from Peru. In the Neotropics, this species has been reported from Mexico, Panama, Jamaica, the Windward Islands, Venezuela, French Guyana, Brazil, and Chile. This species is recognized by the presence of a well-developed cylindrical columella, which is a continuation of the stalk, not calcareous, and almost reaches the apex of the sporotheca. It is also recognized by the profuse but delicate capillitium, with few and small lime nodes.

***Physarum robustum* (Lister) Nann.-Bremek.**

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.176°S, 071.582°W, 2705 m alt.), 28 Jan. 2018, on bryophyte, *I. Treviño & J. Muñuico, Myx-130* (HSP, MA-Fungi 91753).

Identification. Sporocarps grouped, stalked, 1–1.5 mm in total height. Hypothallus membranous, common to a group of sporocarps, effuse, opaque. Stalk cylindrical, erect, longitudinally grooved, 0.6–0.8 mm long, 0.07–0.11 mm wide, narrow toward apex, pale yellow (89. p. Y), darker below by absorbed dirt particles. Sporotheca globose, 0.4–0.8 mm in diameter. Peridium membranous, single, impregnated with lime, white (263. White), thin, fragile, dehiscence irregular somewhat petaloid. Pseudocolumella present, formed by aggregation of lime nodes of the capillitium, as a flat basal thickening, whitish (92. y. White). Capillitium netted, radiating, with oblong to fusiform lime nodes, white (263. White), coalescent into pseudocolumella, connected by colourless tubules of 2 µm in diameter. Spores free, dark brown (47. d. gy. r Br) in mass, grayish brown (45. l. gy. r Br) by TL, globose, 10.5–13 µm in diameter, warted.

Notes. This species is distributed worldwide but not previously reported from Peru. In the Neotropics, this species has only been reported from Mexico and Argentina. Our specimen resembles *P. leucophaeum* Fr. & Palmquist and *P. leucopus* Link, but it is distinguished by the presence of a pseudocolumella in the center of the sporotheca combined with the dense capillitium radiating from there (see Nannenga-Bremekamp 1991). *Physarum leucopus* can be also distinguished by the white stalk filled with lime (Nannenga-Bremekamp 1973).

***Physarum sessile* Brândza**

Figures 3 D, E

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.172°S, 071.596°W, 2662 m alt.), 1 June 2018, leaf litter, *I. Treviño & S. Huamaní, Myx-514* (HSP, MA-Fungi 91804).

Identification. Sporocarps to plasmodiocarps, grouped, sessile. Hypothallus inconspicuous. Sporotheca subglobose, 0.4–0.6 mm in diameter in the sporocarps, 1.5–6 × 0.4–0.6 × 0.4–0.6 mm in plasmodiocarps, white (263. White). Peridium membranous, single, frosted by white lime granules, thin, fragile, tuberculate at the inner face, dehiscence irregular. Capillitium netted, with white (263. White), polygonal lime nodes, connected by colourless tubules of 1–2 µm wide. Spores free, dark brown (62. d. gy Br) in mass, brownish (79. l. gy. y. Br) by TL, subglobose, 7.5–9 µm in diameter, minutely warted.

Notes. This species is known from Europe, Japan, USA, Morocco, Mozambique, and Angola (Ndiritu et al. 2009; GBIF 2020). In the Neotropics, it was previously reported only from Colombia, Venezuela, and Brazil. This species has been rarely collected from tropical forests. Apparently it is widely distributed in the mountains of Moldavia (Romania), from where it was described. According to Farr (1976), the characters to identify this species are a white to greenish or bluish gray sporangia and plasmodiocarps (these shades are not observed in our material), a fragile single peridium, a persistent capillitium with rounded or polygonal lime nodes of 15–25 µm in diameter, and light brown spores of 6–8 µm in diameter. The spores, in our collection, are slightly bigger.

Stemonitis pallida Wingate

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.175°S, 071.599°W, 2734 m alt.), 31 May 2018, decomposed on bark of a dead tree, *I. Treviño & S. Huamaní, Myx-501* (HSP, MA-Fungi 91801).

Identification. Sporocarps grouped, stalked, 2.2–2.7 mm in total height. Hypothallus membranous, usually common to a group of sporocarps, discoid to effuse, shiny. Stalk cylindrical, 0.5–0.6 mm long, 0.04–0.05 mm wide, black (267. Black). Sporotheca subcylindrical, 1.7–2.1 × 0.35–0.55 mm, grayish brown (60. l. gy. Br). Columella cylindrical but slightly attenuate toward the apex, 1.7–2.1 mm long, 0.03–0.04 mm in diameter, black (267. Black), reaching the apex of the sporotheca. Capillitium netted arising from the columella, threads 2–5 µm in diameter, branched and anastomosed, flexuous, brown (57. l. Br-58. m. Br) by TL. Spores free, grayish brown (60. l. gy. Br) in mass, light brown (57. l. Br) by TL, globose, 6–7.5 µm in diameter, minutely warted.

Notes. Widely distributed but not previously reported from Peru. This species resembles *S. flavogenita* E. Jahn from which differ in the size of the spores (6–7.5 µm in *Stemonitis pallida* vs 7–9 µm in *S. flavogenita*) and the absence of membranous expansions in the apex of the columella.

Trichia decipiens (Pers.) T. Macbr.

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.173°S, 071.594°W, 2821 m alt.), 1 June 2018, on bark of dead tree, *I. Treviño & S. Huamaní, Myx-521* (HSP). Wayqecha Biological Station (Perdiz trail), (13.1765°S, 071.585°W, 2884 m alt.), 28 Jan. 2018, leaf of *Puya membranacea, I. Treviño & J. Muñuico, Myx-156* (HSP). Wayqecha Biological Station, (13.179°S, 071.582°W, 2748 m alt.), 29 May 2018, on bark of dead tree, *I. Treviño & S. Huamaní, Myx-406* (HSP, MA-Fungi 91786).

Identification. Sporocarps scattered or grouped, stalked, 1–1.9 mm in total height. Hypothallus membranous, individual or common to a group of sporocarps, discoid to effuse, shiny. Stalk cylindrical, erect, 0.4–0.7 mm long, 0.1–0.2 mm wide, brown (58. m. Br), filled with cysts of 15–17 µm in diameter. Sporotheca subglobose to ovoid, 0.6–1.2 × 0.7–1.1 mm. Peridium membranous, partially evanescent, remaining at the base as a calyculous, with a smooth revolute margin, orange-brown (72. d. O Y) to olive-brown (94. l. Ol Br), dehiscence irregular. Capillitium an elastic network of threads arising from the base of the sporotheca, threads of 6–7.5 µm in diameter, yellow (83. brill. Y) by TL, flexuous, scarcely branched, with acute free ends of 75–100 µm long, ornamented with 4 or 5 spiral bands. Spores free, yellow (83. brill. Y) in mass, light yellow (86. l. Y) by TL, globose, 10–11 µm in diameter, delicately subreticulate.

Notes. This species is widely distributed, including in the Neotropics, but has not previously been reported from Peru. This species is distinguished from other species by the presence of a stalk filled with cysts, the long attenuate ends of the threads, and the spores ornamented with a delicate subreticulum.

Trichia verrucosa Berk.

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.177°S, 071.581°W, 2712 m alt.), 29 May 2018, on bark of dead tree, *I. Treviño & S. Huamaní, Myx-391* (HSP, MA-Fungi 91781). Wayqecha Biological Station, (13.1746°S, 71.599°W, 2690 m alt.), 31 May 2018, on bark of dead tree and bryophyte, *I. Treviño & S. Huamaní, Myx-508* (HSP, MA-Fungi 91803).

Identification. Sporocarps aggregated, stalked, usually several sporocarps united by the stalks, 1.6–2.6 mm in total height. Hypothallus membranous, common to a group of sporocarps, effuse, opaque. Stalk weak, flattened, longitudinally grooved, 0.8–1.2 mm long, 0.1–0.15 mm wide, yellow (86. l. Y). Sporotheca obovoid, 0.8–1.4 × 0.5–1 mm, yellow (83. brill. Y) to orange yellow (72. d. O Y). Peridium membranous, single, partially evanescent, remaining at the basal part as a calyculous, thin, fragile, the inner side papillate, dehiscence irregular. Capillitium an elastic network of threads arising from the base of the sporotheca, threads of 5–7 µm in diameter, yellow (86. l. Y) by TL, flexuous, scarcely branched, with acute free ends of 10–12.5 µm long, ornamented with 4 or 5 spiral bands. Spores free, yellow (83. brill. Y) in mass, light yellow (86. l. Y) by TL, globose, 11–12.5 µm in diameter, reticulate.

Notes. This species is distributed worldwide distributed but has not previously been reported from Peru. In the Neotropics, it was reported from Mexico, Costa Rica, Cuba, Jamaica, Windward Islands, Colombia, Brazil, Chile, and Argentina. *Trichia verrucosa* is the only stipitate species in genus *Trichia* that has coarsely reticulate spores. By the ornamentation of the spores it resembles *T. favoginea* (Batsch) Pers., but differs by the long stalks and the sporocarps often clustered on a united stalk.

***Tubifera ferruginosa* (Batsch) J.F. Gmel.**
Figures 3 F–G

New record. PERU: Cusco, Paucartambo. Kosñipata: Wayqecha Biological Station, (13.179°S, 071.582°W, 2769 m alt.), 2 Feb. 2018, on bark of dead tree, *I. Treviño & J. Muñuico, Myx-353* (HSP, MA-Fungi 91775).

Identification. Sporocarps densely aggregated in a pseudoaethalium, sessile, spreading over 0.5–0.9 cm. Hypothallus membranous, common to a group of sporocarps, effuse, opaque. Sporotheca subcylindrical, 5–7 × 0.9–1.2 mm, yellowish brown (77. m. y Br). Peridium membranous, single, thin, fragile, dehiscing at the apex by a lid or irregularly. Capillitium absent. Spores free, yellowish brown (76. l y Br) in mass, pale yellow (89. p. Y) by TL, globose, 6–7 µm in diameter, almost completely reticulated.

Notes. This species is distributed worldwide but has not previously been reported from Peru. In the Neotropics, it has been reported from Mexico, Costa Rica, Panama, Jamaica, Dominican Republic, Puerto Rico, the Leeward and Windward islands, French Guyana, Brazil, Ecuador, Chil,e and Argentina. This species is characterized by a large pseudoaethalium formed by sessile and cylindrical sporocarps on a spongy hypothallus (Nannenga-Bremekamp 1991). It differs from other species with sessile sporocarps as *Tubifera casparyi* (Rostaf.) T. Macbr. and *Tubifera dictyoderma* Nann.-Bremek. & Loer. by the absence of a well-developed filamentous columella, and from *Tubifera applanata* (Leontyev & Fefelov) Leontyev & Fefelov by the apex of the sporotheca conical or hemispherical in *T. ferruginosa* vs flat and angular in *T. applanata*.

Discussion

Knowledge of the Myxomycetes in the Neotropics is still fragmentary, as the sampling effort undertaken has not been homogeneous. The unique monograph on this biogeographical region has been published almost 50 year ago by Farr (1976). Despite the efforts made in recent years by Bezerra et al. (2014), Lado et al. (2017, 2018), and Rojas et al. (2018) in some Neotropical countries, the study of this group of microorganisms is still scanty, compared to elsewhere, like Europe or North America. According to Lado and Wrigley de Basanta (2008), Neotropical countries with large territories and rich and varied vegetation and environments, such as Peru, Colombia, and Bolivia have few records of Myxomycetes but enormous areas remain unexplored. The five countries with the highest number of myxomycete species recorded in the Neotropics are Mexico (323 spp.), Brazil (206 spp.), Argentina (160 spp.), Costa Rica (143 spp.), and Ecuador (136 spp.). For Peru, in 2008, only 31 species were recorded (Lado 2008). Countries such as Ecuador and Costa Rica, which have smaller areas, possess a known myxobiotas that are four times larger than Peru and show how poorly studied Peru was for these microorganisms. Unfortunately, collections of Myxomycetes in local herbaria do not exist, and the lack of specialists in the country, the scanty funding sources, and the low interest of the local scientific community, do not facilitate a better knowledge of the group.

Nevertheless, during the last decade, four species new to science have been described in the framework of the Myxotropic project (http://www.myxotropic.org/), *Didymium peruvianum* Lado, D. Wrigley & S.L. Stephenson, *Didymium xerophylum* Lado, Estrada & D. Wrigley, *Licea aurea* D. Wrigley, Lado & Estrada, and *Cribraria spinispora* Lado & D. Wrigley. Moreover, 120 new records have been reported in the Peruvian territory; the studies of Wrigley de Basanta et al. (2015, 2019) and Lado et al. (2016, 2019) in arid zones and Andean environments of the country, are the major contributors to this increased knowledge. Taking into account that over 50% of Peruvian territory is covered with rainforest (Amazonian territory) and considering that Myxomycetes grow probably better under humid environments, it can be expected that a larger diversity will be uncover when expanding the surveys to the whole territory.

The data provided in this paper represent the first set of information of the Myxomycetes in the montane forests of Peru. This is an environment virtually that has been unexplored in this country until now, with only two species, *Perichaena depressa* Lib. and *Didymium iridis*, reported by Rojas et al. (2011) and Rojas and Stephenson (2013) from the same area as in our study (Wayqecha Biological Station). These works were focused mostly on southwestern Peru, more specifically the Madre de Dios tropical forest, which leaves montane forests practically unsurveyed.

In this paper only records of newly recorded species for Peru were considered. In total, we recorded 81 species of Myxomycetes from WBS (Treviño, unpubl. data) including 19 new records. These results are in line with those obtained by Schnittler et al. (2002) in the montane forest of the Maquipucuna Reserve in Ecuador where 77 species were inventoried. This suggests the potential richness in species of the Peruvian montane forests and the need to make more efforts towards the study of this environment, which could provide a significant contribution to the myxomycete diversity of the country.

The fact that two genera, *Macbrideola* and *Tubifera,* are reported for the first time for Peru is of particular interest. The distribution of *Macbrideola spinosispora* is expanded considerably by this first record from South America. The type specimen was found in Guanacaste province, Costa Rica, in a tropical dry forest (Rojas et al. 2018), which has a considerably different climate from the tropical montane forests of our study. This demonstrates a rather wide ecological tolerance for this species, and it therefore suggests a wider distribution in the Neotropics. The apparently disjunct distribution of this species may well be an artifact of it being inconspicuous. Its small size (less than 0.4 mm in total height) may be

the reason why it has remained overlooked. Indeed, it is extremely difficult to observe it in the field, and it can be only reliably detected using a moist chamber and observation with a dissecting microscope.

Tubifera ferruginosa, in contrast, is a species widely distributed in the Neotropics, documented in countries neighboring Peru, such as Brazil, Ecuador, and Chile, but has not been reported from Peru before now. According to Farr (1976), this is a cosmopolitan species, and its distribution is not only restricted to montane forests, but also encompasses the lowlands of the Amazon and other habitats. The relatively limited sampled effort undertaken in tropical forests of Peru could be the reason why this species has not been previously reported in this country.

Some other rare species reported in this paper, such as *Comatricha alta* and *Diderma fragile,* might have a wider distribution. These species occur in Europe as well as in southern South America, and our data constitute one of the few records of these species in the Neotropics. Their distribution in Peru is probably not limited to the montane forests, but a more detailed study of the territory and a larger number of collections are necessary to document their distribution more precisely. It could be expected that these two species could be more abundant above 3000 m a.s.l., and on the eastern side of the Andean mountain range, as they were not recorded in the extensive studies of Lado et al. (2016, 2019) who conducted fieldwork at lower altitudes and on the western slopes of the Andes.

In general, the morphology of the species shown in this paper corresponds well with the descriptions given in the literature for specimens from other countries or even continents. However, some species show variation in the colour or size of the fruiting bodies. Our specimens of *Craterium minutum*, for example, lack a pseudocolumella, which is a feature usually common in this species and mentioned in almost all monographs. This might suggest the presence of a Peruvian morphotype, or it might be the result of micro-environmental conditions associated with the substrate on which these specimens developed.

With the 19 species recorded in this article, the myxobiota of Peru is increased to 174 species, which ranks Peru among the five countries with the most diversity of Myxomycetes of the Neotropics.

Acknowledgements

We thank the Association for the Conservation of the Amazon Basin (ACCA), Michael Owen Dillon Scientific Institute (IMOD), the Real Jardín Botánico de Madrid (CSIC), and the Government of Spain (Myxotropic Project, CGL2014-52584P, PGC2018-094660-B-I00) for funding the fieldwork, for the use of equipment of scientific research, and for the laboratory infrastructure. We are also grateful for the assistance of John Muñuico, Susan Huamaní, and the staff of the Wayqecha Biological Station for the facilities provided during our fieldwork. We also thank Diana Wrigley de Basanta and Enrique Lara for linguistic revision of the text and Carlos de Mier for his help with the images and micrographs.

Authors' Contributions

IT collected and identified part of the material, wrote the manuscript draft, and made all the descriptions and illustrations. CL identified part of the material, co-wrote the draft manuscript, and provided the laboratory component of the project.

References

Arambarri AM (1973) Myxomycetes de Tierra del Fuego I. Especies nuevas y críticas del género Diderma (Didymiaceae). Boletín de la Sociedad Argentina de Botánica 15: 175–182.

Bezerra ACC, Lima VXL, Tenorio JC, Cavalcanti LH (2014) Myxomycetes from the state of Alagoas (Brazil) and notes on its distribution. Biotemas 27: 13–22.

Farr M (1976) The Myxomycetes. Flora Neotropica 16. The New York Botanical Garden, New York, USA. 304 pp.

GBIF (2020) GBIF home page. https://www.gbif.org. Accessed on 2020-01-18.

Ing B (1999) The myxomycetes of Britain and Ireland. Richmond Publishing, Slough, UK, 374 pp.

Kelly KL (1965) ISCC-NBS Colour-name charts illustrated with centroid colors. Inter-Society Colors Council. National Bureau of Standards, Circular 553 (Supplement). US Government Printing Office, Washington, DC, 44 pp.

Kirk P, Cannon P, Minter D, Stalpers J (2011) Dictionary of the Fungi. CABI International. Oxon, UK, 748 pp.

Lado C, Pando F (1997) Myxomycetes, I. Ceratiomyxales, Echinosteliales, Liceales, Trichiales. Flora Mycologica Iberica. (2):1–323.

Lado C (2005–2019) An online nomenclatural information system of Eumycetozoa. Real Jardín Botanico, CSIC, Madrid, Spain. http://www.nomen.eumycetozoa.com. Accessed on 2019-07-20.

Lado C, Wrigley de Basanta D (2008) A review of Neotropical Myxomycetes (1828–2008). Anales del Jardín Botánico de Madrid 65 (2): 211–254. https://doi.org/10.3989/ajbm.2008.v65.i2.293

Lado C, Wrigley de Basanta D, Estrada-Torres A, Stephenson SL (2013) The biodiversity of myxomycetes in central Chile. Fungal Diversity 59: 3–32. https://doi.org/10.1007/s13225-012-0159-8

Lado C, Wrigley de Basanta D, Estrada-Torres A, Stephenson SL (2016) Myxomycete diversity in the coastal desert of Peru with emphasis on the lomas formations. Anales del Jardín Botánico de Madrid 73 (1): e032. https://doi.org/10.3989/ajbm.2436

Lado C, Estrada-Torres A, Wrigley de Basanta D, Schnittler M, Stephenson SL (2017) A rapid biodiversity assessment of myxomycetes from a primary tropical moist forest of the Amazon basin in Ecuador. *Nova Hedwigia* 104 (1–3): 293–321. https://doi.org/10.1127/nova_hedwigia/2016/0372

Lado C, Estrada-Torres A, Rojas C (2018) New records of genera and species of Myxomycetes (Amoebozoa) from the Neotropics. *Check List* 14 (3): 509 –518. https://doi.org/10.15560/14.3.509

Lado C, Wrigley de Basanta D, Estrada-Torres A, Stephenson SL, Treviño-Zevallos I (2019) Diversity of Myxomycetes in arid zones of Peru part II: the cactus belt and transition zones. Anales del Jardín Botánico de Madrid 76 (2): e083. https://doi.org/10.3989/ajbm.2520

Martin GW, Alexopoulos CJ (1969) The Myxomycetes. University of Iowa Press, Iowa City, Iowa, USA, 561 pp.

Medina C, Zeballos H, López E (2012) Diversidad de mamíferos en los bosques montanos del valle de Kosñipata, Cusco, Perú. Mastozoología Neotropical 19 (1): 85–104.

Mitchell DW (1995) The Myxomycota of Australia. Nova Hedwigia 60: 269–295.

Nannenga-Bremekamp NE (1973) Notes on Myxomycetes XIX. Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Series C, Biological and Medical Sciences 76: 476–488.

Nannenga-Bremekamp NE (1991) A guide to temperate Myxomycetes. Biopress, Bristol, UK, 409 pp.

Ndiritu G, Winsett K, Spiegel F, Stephenson S (2009) A checklist of African Myxomycetes. Mycotaxon 107: 353–356. https://doi.org/10.5248/107.353

Poulain M, Meyer M, Bozonnet J (2011) Les myxomycètes. Fédération Mycologique et Botanique Dauphiné–Savoie, Sévrier, 545 pp.

Rivera G (2007) Composición florística y análisis de diversidad arbórea en un área de bosque montano en el Centro de Investigación Wayqecha, Kosñipata Cusco. Tesis para optar el Título de Ingeniera Forestal. Facultad de Ciencias Forestales Universidad Nacional Agraria La Molina, 84 pp. http://repositorio.lamolina.edu.pe/bitstream/handle/UNALM/1695/F70.R62-T.pdf. Accessed on: 2019-01-01.

Rojas C, Stephenson SL (2013) Effect of forest disturbance on myxomycete assemblages in the southwestern Peruvian Amazon. Fungal Diversity 59: 45–53.

Rojas C, Stephenson, SL, Pavlich M (2011) New additions to the myxobiota of Peru. Mycosphere 2 (5): 583–592. https://doi.org/10.5943/mycosphere/2/5/8

Rojas C, Lado C, Rojas PA (2018) Myxomycete diversity in Costa Rica. Mycosphere 9 (2): 227–255. https://doi.org/10.5943/mycosphere/9/2/6

Schnittler M, Lado C, Stephenson SL (2002) Rapid biodiversity assessment of a tropical myxomycete assemblage—Maquipucuna Cloud Forest Reserve, Ecuador. Fungal Diversity 9: 135–167.

Stephenson SL (2003) Myxomycetes of New Zealand. Fungi of New Zealand. Volume 3. Fungi Diversity Research Series 11: 1–238.

Walker L, Moreno G, Stephenson S (2014) A new species of *Macbrideola* from Costa Rica. Boletín de la Sociedad Micológica de Madrid 38: 63–66.

Wrigley de Basanta D, Estrada-Torres A, Lado C (2019) *Licea aurea* a new Myxomycete from the Peruvian Andes. *Phytotaxa 391* (3): 218–224. https://doi.org/10.11646/phytotaxa.391.3.5

Wrigley de Basanta D, Lado C, García-Martín JM, Estrada-Torres A (2015) *Didymium xerophilum*, a new myxomycete from the tropical Andes, Mycologia 107 (1): 157–168. https://doi.org/10.3852/14-058

Wrigley de Basanta D, Stephenson SL, Lado C, Estrada-Torres A, Nieves-Rivera AM (2008) Lianas as a microhabitat for myxomycetes in tropical forests. Fungal Diversity 28: 109–125. https://doi.org/10.1007/s13225-013-0236-7

Wrigley de Basanta D, Estrada-Torres A (2017) Techniques for recording and isolating Myxomycetes. In: Stephenson SL, Rojas C (Eds) Myxomycetes. Biology, systematics, biogeography and ecology. Academic Press, Amsterdam, The Netherlands, 333–363. https://doi.org/10.1016/b978-0-12-805089-7.00010-x

Yamamoto Y, Kimura T, Degawa Y (2006) Tropical slime mold, *Diderma subdictyospermum*, new to Japan. Bulletin of The Kanagawa Prefectural Museum Natural Science 35: 33–34.

Young K, León B (2001) PERU. In: Kappelle, M; Brown, AD (Eds) Bosques nublados del neotrópico. Santo Domingo de Heredia, Costa Rica, Instituto Nacional de Biodiversidad INBIO, 549–580.